The Wilson Journal of Ornithology 119(1):28–34, 2007

USE OF NEST BOXES BY GOLDENEYES IN EASTERN NORTH AMERICA

JEAN-PIERRE L. SAVARD[1] AND MICHEL ROBERT[1,2]

ABSTRACT.—We evaluated and monitored use of 105–133 nest boxes by Common Goldeneye (*Bucephala clangula*) and Barrow's Goldeneye (*Bucephala islandica*) during 1999–2004 on 60 lakes of high plateaus of the Laurentian Highlands, in the boreal forest of Québec, Canada. Only three species of birds used nest boxes regularly, American Kestrel (*Falco sparverius*), Barrow's Goldeneye, and Common Goldeneye. The proportion of nest boxes used by goldeneyes in 2000–2004 ranged from 23 to 43% whereas hatching success ranged from 37 to 67%. Successful Barrow's and Common goldeneye clutches averaged 6.76 ± 0.38 (SE, n = 29) and 7.77 ± 0.44 eggs (n = 31), respectively. Predation in nest boxes was not a major mortality factor. Goldeneyes used all nest boxes independent of their location but reproductive success was lower in nest boxes 25–160 m from shore in clearcuts. The number of Barrow's and Common goldeneye breeding pairs increased between 1999 and 2003, but number of broods remained stable after an increase in 2000. *Received 15 December 2005. Accepted 12 August 2006.*

The eastern population of Barrow's Goldeneye (*Bucephala islandica*) is estimated at ~1,400 pairs (Robert et al. 2000a) and was classified as Special Concern by the Committee on the Status of Endangered Wildlife in Canada in November 2000 (COSEWIC 2006). Its breeding range has been discovered only recently in the Québec Laurentian Highlands, on the north shore of the St. Lawrence River estuary and gulf (Robert et al. 2000b). It breeds on small lakes, often without fish at >500 m in elevation (Robert et al. 2000b), where tree growth is slow and large trees with suitable nest cavities are apparently rare (MR, pers. obs.). Forests in its breeding area are under intense logging pressures (Robert et al. 2000a) and availability of suitable nesting cavities is an issue of concern.

Nest boxes have been used successfully to locally increase the abundance of cavity-nesting waterfowl (McLaughlin and Grice 1952, Johnson 1967, Nichols and Johnson 1990) and to establish new populations (Doty and Kruse 1972, Eriksson 1982, Dennis and Dow 1984). Barrow's Goldeneyes have readily used nest boxes in British Columbia (Savard 1985, 1988) and their use has increased the number of broods locally. The small Icelandic population uses nest boxes as well (JPS and MR, pers. obs.). Nest boxes have been useful in reducing the impact of logging on Common Goldeneyes (*Bucephala clangula*) in Scandinavia (Cramp and Simmons 1977). Nest-box programs have proven successful overall for most cavity-nesting ducks (Zicus 1990, Hepp and Bellrose 1995, Eadie et al. 1995), but potential problems could reduce their efficiency. These include increased predation rates, nest parasitism, and increased competition for adequate brood-rearing ponds (Andersson and Eriksson 1982, Savard 1988, Eadie et al. 1995, Evans et al. 2002, Pöysä and Pöysä 2002). Nest boxes in British Columbia had larger clutch sizes, lower nesting success, and a different suite of predators than natural nests (Evans et al. 2002). There is also the underlying risk that nest-boxes may attract predators and become ecological traps (Battin 2004). A related concern is inter-specific competition between Barrow's and Common goldeneyes, which use similar nest sites and exclude each other from pair and brood territories (Savard 1982, 1984), and are known to occasionally hybridize (Martin and Di Labio 1994).

We examined use of nest boxes by Barrow's Goldeneyes in their high elevation breeding habitat. Specifically we: 1) evaluated use of nest boxes by goldeneyes and other wildlife in the only known Barrow's Goldeneye habitat accessible by road, 2) measured goldeneye reproductive success in nest boxes, 3) compared nest-box use in relation to box location, and 4) compared the relative abundance of Common and Barrow's goldeneye pairs and broods.

[1] Canadian Wildlife Service, Environment Canada, 1141 Route de l'Église, P. O. Box 10100, Sainte-Foy, QC, G1V 4H5, Canada.
[2] Corresponding author;
e-mail: michel.robert@ec.gc.ca

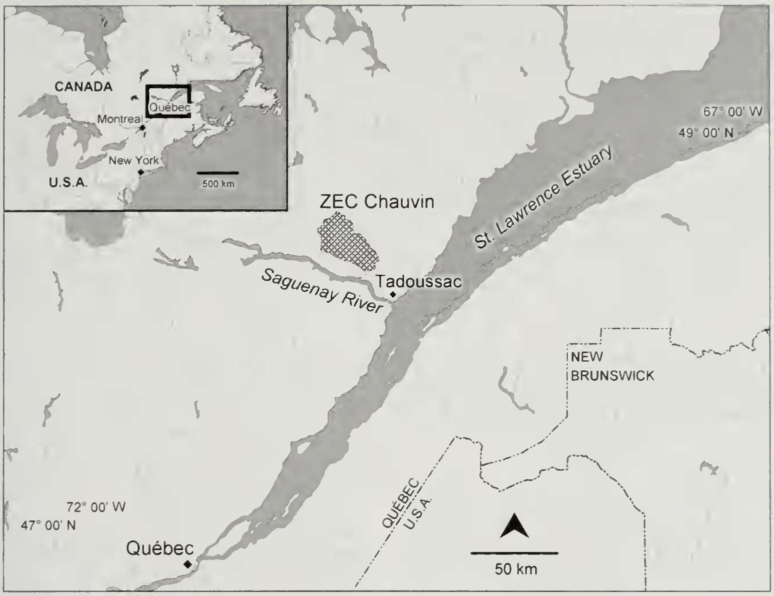

FIG. 1. Goldeneye nest box study area (ZEC Chauvin) in the Laurentian Highlands north of the St. Lawrence River estuary, in the boreal forest of Québec, Canada.

METHODS

Study Area.—The study was conducted in the Zone d'exploitation controlée (ZEC) Chauvin, a 610-km² area ~40 km northeast of Tadoussac (48° 09′ N, 69° 43′ W), Québec, Canada (Fig. 1). ZEC Chauvin is on high plateaus of the Laurentian Highlands, north of the St. Lawrence River estuary, in the balsam fir (*Abies balsamea*)-white birch (*Betula papyrifera*) bioclimatic domain of the boreal forest. Mean annual temperature and precipitation are 0.0° C and 1,300 mm (35% as snow), respectively (Robitaille and Saucier 1998). Common and Barrow's goldeneye pairs and broods use the lakes of this area (Robert et al. 2000a), which is under intense forest exploitation and is managed for hunting, fishing, and other recreational activities.

Nest Boxes.—We installed 111 nest boxes in August–September 1998 at 37 lakes in the study area, three per lake: one above water on a steel post (mean distance from shore = 6.6 m, range = 3–18; mean height above water = 1.4 m, range = 0.08–2.2), one on a tree at the edge of the lake (mean distance from water edge = 4.1 m, range = 0.8–12.7; mean height above ground = 4.0 m, range = 3.4–4.5), and one on a tree or snag in a recent clearcut (mean distance from water edge = 74.6 m, range = 25–160; mean height above ground = 4.0 m, range = 3.3–5.3). We also installed 25 single nest boxes in September 1999 on a tree or snag in clearcuts near additional lakes. All nest boxes were highly visible, measured 24 × 22 × 60 cm, and had an entrance hole measuring 10 × 13 cm. Nest boxes were checked between 1999 and 2004, at least twice in 1999 (once in mid incubation and once after hatching) and usually at least three times in 2000–2004, with a first visit at the end of egg-laying. Occupied boxes were checked more often (i.e., 4–6 times) to better estimate clutch size and capture females. Sixteen Barrow's Goldeneye females were captured in nest boxes and fitted with backpack radio-transmitters in 2001–2003 to study brood ecology. None was recaptured or seen again on the study area in 2002–2004 (Robert et al. 2006).

Pair and Brood Counts.—We conducted Barrow's and Common goldeneye pair and brood surveys in a 217-km² area of ZEC Chauvin encompassing all lakes with three nest boxes, as well as 19 of 25 lakes with single boxes. This area includes 239 lakes (mean = 5.4 ha, SD = 11.3, range = 0.01–115), of which 132 are <2 ha. We surveyed goldeneye pairs on 60 lakes of this area each

TABLE 1. Number of goldeneye nest boxes used[a]; boxes were installed in fall 1998 (*n* = 111) and 1999 (*n* = 25) in the boreal forest of Québec, Canada.

	1999	2000	2001	2002	2003	2004
Barrow's/Common goldeneyes	1	30	35	56	54	36
American Kestrel[b]	12	22 (1)[c]	27 (1)[c]	27 (3)[c]	8 (1)[c]	2
Hooded Merganser[b]	0	0	0	2 (3)[c]	0 (3)[c]	2
Tree Swallow (*Tachycineta bicolor*)	3	2	0	0	0	0
Northern Flicker (*Colaptes auratus*)	1	1	1	0	1	0
Red Squirrel[b]	0	1	8 (1)[c]	4	8 (7)[c]	3 (1)[c]
Boxes available	105	133	127	130	133	128
Boxes used	17	56	71	89	71	43
Percent used	16	42	56	69	53	34

[a] At least one egg was found or in the case of squirrels, a nest.
[b] Some nest boxes were used by more than one species during a given year.
[c] The number in parenthesis represents species in double occupancy.

year between 21 May and 28 June 1999–2003. We surveyed most (75%) lakes only once in 1999 (late May), and most (>75%) at least twice in subsequent years (late May and in early to mid-Jun). All goldeneyes were recorded as pair, lone adult male, lone adult female, groups of adult males and/or females, and immature female or male (i.e., second-year [SY] individuals). We used the maximum number of adult males seen on each particular lake in a given year summed across all lakes to derive a measure of pair abundance in the study area. We also surveyed goldeneye broods on the same lakes. Survey efforts were less intensive in 1999 when 27% of the lakes were surveyed once and 46% twice during the brood season (20 Jun to 11 Sep). From 2000 to 2003, most lakes (77%) were surveyed ≥3 times. We used head shape and color, bill shape, and wing pattern to separate Common and Barrow's goldeneye females (Tobish 1986). Adult and immature females were separated by iris color (Tobish 1986). We combined the number of immature females identified with the number of females of undetermined age (there were few and most were likely immatures), as an estimate of immature abundance in the study area.

Statistics.—Means ± SE are presented. We used analysis of variance to compare means. Differences in frequency were tested using χ^2 and Pearson's standardized residuals (Agresti 2002). All nest boxes were used to estimate the overall use of nest boxes by wildlife, but analysis of nest-box use in relation to location was limited to lakes with properly located trios of boxes (*n* = 29–35 lakes).

RESULTS

Nest Boxes.—Between 105 and 133 boxes were available yearly (1999–2004), and were used by six species of birds (Table 1). The proportion of boxes used increased from 16% in 1999 to 69% in 2002, and decreased to 34% in 2004. Barrow's and Common goldeneyes were the major users in all years but 1999 followed by American Kestrels (*Falco sparverius*). Kestrels dominated box use in 1999 (*n* = 12) and their use peaked in 2001 (*n* = 27) and 2002 (*n* = 27) before abruptly decreasing in 2003 (*n* = 8) and 2004 (*n* = 2). Hooded Mergansers (*Lophodytes cucullatus*) used boxes in 2002 and 2004 (two nests each year). Some boxes were used by more than one species in the same year. Six cases each involved goldeneyes and American Kestrels, and goldeneyes and Hooded Mergansers. Eight involved goldeneyes nesting on unoccupied red squirrel (*Tamiasciurus hudsonicus*) nests, of which seven successfully hatched. There was one instance of an American Kestrel nesting on a red squirrel nest.

Both Common and Barrow's goldeneyes used nest boxes (Table 2), although the relative use by each species could not be ascertained because of the large proportion of boxes where species of goldeneye could not be identified. Only one box was used by goldeneyes in 1999. Box use increased to 30 in 2000, peaked at 56 and 54 in 2002 and 2003 respectively, and decreased to 36 in 2004. Goldeneye hatching success (≥1 egg hatching) ranged between 37 and 67% (Table 3). Eighty-five of 110 nest failures (no egg hatch-

TABLE 2. Number of nest boxes used by Barrow's and Common goldeneyes; boxes were installed in fall 1998 (n = 111) and 1999 (n = 25) in the boreal forest of Québec, Canada.

	1999	2000	2001	2002	2003	2004	Totals[a]
Number of boxes	105	133	127	130	133	128	651
Barrow's Goldeneye	0	9	7	12	11	4	43
Common Goldeneye	0	9	10	19	9	6	53
Goldeneye sp.	1	12	18	25	34	26	115
All goldeneyes	1	30	35	56	54	36	212
Used by goldeneyes (%)	1	23	28	43	41	28	33

[a] Excludes 1999.

ing) were associated with partial or complete egg loss, 15 with no egg loss, and 10 for which egg loss could not be ascertained. Only 28 nests had obvious signs of predation (i.e., broken eggshells or presence of dry yolk) and at least 10 females successfully hatched eggs in spite of partial egg loss (1–5) during incubation. There were no signs of predation or broken eggs in all cases. More nest failures occurred after incubation had started (57%, n = 107 nests).

Four clutches had >12 eggs (13–15). All boxes with <3 eggs were unsuccessful, but five of eight 3-egg clutches and two of six 4-egg clutches were successful. A similar proportion of <6-egg (32.7%, n = 49) and >9-egg (36.4%, n = 22) clutches hatched successfully (χ^2 = 0.093, P = 0.76, df = 1). Clutches of 6–9 eggs had a greater (67.1%, n = 70) hatching success than clutches with <6 eggs (χ^2 = 13.7, P < 0.001, df = 1) and >9 eggs (χ^2 = 6.6, P = 0.01, df = 1). The average clutch size of successful goldeneyes increased during the first 3 years (2000 = 7.22 ± 0.55 eggs, n = 18; 2001 = 7.85 ± 0.37, n = 13; 2002 = 8.13 ± 0.68, n = 15) and decreased in the next 2 years (2003 = 7.31 ± 0.71, n = 16; 2004 = 6.78 ± 0.92, n = 9). These changes are not significant (F = 1.23, P = 0.30). Successful Barrow's Goldeneye clutches were smaller (6.76 ± 0.38, n = 29) than those of Common Goldeneyes (7.77 ± 0.44, n = 31; F = 3.0, P = 0.088). The same difference was observed for unsuccessful clutches (6.62 ± 0.36, n = 37 vs. 7.52 ± 0.35, n = 46; F = 3.17, P = 0.079).

TABLE 3. Nest success of goldeneyes in nest boxes installed in fall 1998 (n = 111) and 1999 (n = 25) in the boreal forest of Québec, Canada.

		Nest fate		
Year	Nests	Hatched[a] (%)	Failed (%)	Unknown (%)
1999	1	0	100	0
2000	30	67	27	7
2001	35	40	57	<1
2002	56	37	61	<1
2003	54	41	56	<1
2004	36	53	47	0
Totals	212	45	52	<1

[a] At least one egg hatching.

Goldeneyes used all boxes independently of their location (above water, along shoreline or >25 m from shore) in all years (Table 4; χ^2 = 5.50, P = 0.70, df = 8). Goldeneyes using nest boxes in clearcuts were slightly less successful (40%, n = 86) than those using boxes along the shoreline (56%, n = 63) or above water (50%; n = 56, χ^2 = 4.51, P = 0.11, df = 2). Pearson's standardized residuals confirmed that boxes in clearcuts were less successful than others (above water = 0.45; along shoreline = 1.71; in clearcuts = −2.00). American Kestrels clearly preferred nest boxes away from water, having used 54 boxes/191 (28%) in clearcuts versus only 10/382 (3%) at the other two locations (χ^2 = 63.3, P < 0.001, df = 1).

Pair and Brood Counts.—There were nearly three times more Barrow's than Common goldeneye males on the study area in 1999 (Table 5). Barrow's and Common goldeneyes had increased from 28 to 43 and from 10 to 46 estimated pairs, respectively, in 2003. The number of immature (SY) females varied between years. The contrast in numbers for both species combined was especially great between 2000 (n = 9) and 2001 (n = 74). This greater number of immatures in 2001 was followed by a marked increase in the number of pairs of both species in 2002. A peak in the

TABLE 4. Location of nest boxes used by goldeneyes; nest boxes were installed in fall 1998 (n = 111) and 1999 (n = 25) in the boreal forest of Québec, Canada.

			Occupied (%)		
Year	Nests (Lakes)[a]	N occupied	Above water	Shoreline	In clearcut
1999	93 (31)	1	1	0	0
2000	102 (34)	30	27	47	27
2001	87 (29)	27	33	33	33
2002	93 (31)	43	37	37	26
2003	105 (35)	44	27	36	36
2004	93 (31)	20	45	20	35

[a] Three nest boxes per lake (one above water, one along the shoreline, and one >25 m from shore).

number of immatures occurred in 2002, followed by an increase in the number of Common Goldeneye pairs in 2003. This increase in pairs did not yield a proportional increase in the number of broods of either species. The brood/pair ratio doubled between 1999 and 2000 and decreased in following years (Table 5).

DISCUSSION

This study is the first to examine use of nest boxes by Barrow's Goldeneye in eastern North America. Goldeneyes were the main users of nest boxes in the study area, confirming their usefulness as a potential management tool in the boreal forest of the Laurentian Highlands. The only other important user of nest boxes in the study area was the American Kestrel. Nest boxes allowed this species to exploit temporary new open habitats created by logging, whereas vegetation regrowth may have contributed to their low use in 2003 and 2004. Rohrbaugh and Yahner (1997) found that boxes frequently used by American Kestrels were associated with extremely open habitat dominated by herbaceous vegetation. The preference of kestrels for nest boxes in clearcuts may be related to the more centralized position of these boxes within the territory which likely allows adults to better protect the nest.

The large increase in nest box use in 2002 corresponds to the time females hatched in 2000 would have initiated first breeding. The decrease in 2003 and especially 2004 may be due to the suspected over winter mortality of several successfully reproducing adult Barrow's Goldeneye females (Robert et al. 2006). Goldeneye hatching success was similar to that reported elsewhere (Savard 1988, Evans et al. 2002). Nest desertion was the major cause of failure similar to other studies (Grenquist 1963, Rajala and Ormio 1970, Eadie et al. 2000). We suspect that competition for nest sites (Erskine 1960, 1990; Lumsden and Wenting 1976), a large number of first year breeders (Grenquist 1963), and disturbances related to fishing may have contributed to the high level of nest desertion. Eadie et al. (1995, 2000) indicated that true clutch size of a single female goldeneye is probably 6–9 eggs. Hatching success of clutches in that range was

TABLE 5. Abundance of Common and Barrow's goldeneyes on 60 lakes of ZEC Chauvin, in the boreal forest of Québec, Canada.

	Barrow's Goldeneye				Common Goldeneye			
Year	Pairs[a]	Broods	Brood/pair	SYF	Pairs[a]	Broods	Brood/pair	SYF
1999[b]	28	10	0.36	12	10	4	0.40	1
2000	24	17	0.71	6	13	11	0.85	3
2001	33	17	0.52	49	13	9	0.69	25
2002	42	15	0.36	70	28	11	0.39	67
2003	43	14	0.33	44	46	7	0.15	49

[a] Pairs + unpaired males.
[b] Number of SY females unreliable for 1999 because only one survey (late May–early Jun) of most (75%) lakes; the number of broods is likely underestimated in 1999.

higher in our study than in smaller and larger clutches. Large clutches are likely caused by nest parasitism, which is frequent in goldeneyes, and often results in nest desertion (Eriksson and Anderson 1982, Eadie and Fryxell 1992). Smaller clutches are often the result of first year breeders which are more prone to desertion (Eadie et al. 2000). Our smallest incubated clutch was three eggs (n = 8, 5 hatching); the previously reported smallest one was four eggs (Eadie et al. 1995, 2000).

Goldeneyes used nest boxes independently of their location. The tendency of fewer goldeneyes using clearcut boxes from 2000 to 2002 may be related to the preference of kestrels for boxes in clearcuts. Goldeneyes used nest boxes at all three locations similarly in 2003–2004 when kestrel use of boxes was low. Pöysä et al. (1999) reported a preference by Common Goldeneyes for nest boxes close to the water over those in forests (46–190 m from shore). They did not find any differences in predation rates between the two locations (Pöysä et al. 1997). Our boxes may have been more conspicuous than those in Pöysä et al.'s (1997, 1999) study, as they were highly visible in clearcuts. Unlike in British Columbia (Savard 1988, Evans et al. 2002), black bears (*Ursus americanus*) were not important predators, with only one box destroyed over the study. Other potential nest predators included red squirrel and marten (*Martes americana*). Mink (*Mustela vison*) were also numerous in the study area but it is unknown whether they can prey on birds or eggs in nest boxes; however we documented predation on Barrow's Goldeneye females and ducklings on two occasions in July 2002.

Numbers of breeding pairs of both Barrow's and Common goldeneyes increased. Our impact on local Barrow's Goldeneye productivity (Robert et al. 2006) may explain partially the greater increase of Common Goldeneye pairs over the course of the study. Goldeneyes have a strong breeding philopatry (Dow and Fredga 1983, Savard and Eadie 1989), so that local reproductive success is important for local population growth. The number of broods increased between 1999 and 2000, when nest box use increased from 1 to 30 boxes and hatching success was high. However, in subsequent years, increase in nest box use did not result in greater brood numbers. This was evident for Common Goldeneyes, especially in 2003 when the brood/pair ratio was only 15%. Pöysä and Pöysä (2002) showed that provision of nest boxes for Common Goldeneyes did not always result in greater productivity because of density dependence factors during nesting and brood-rearing. We believe that nest boxes could be used as a recovery tool for the eastern population of Barrow's Goldeneyes in areas where intensive forest exploitation may limit natural nest sites. However, their potential for increasing productivity may be limited by the availability of local brood rearing habitats.

ACKNOWLEDGMENTS

This study was funded by the Species at Risk Division of the Canadian Wildlife Service, Québec Region; thanks to Isabelle Ringuet. We thank all field personnel for their assistance especially Christian Marcotte and Laurent Dufour, who conducted most surveys and nest box monitoring, and Paul Messier, Hélène Sénéchal, Réjean Benoit, Dominique Bourget, Jean-François Rousseau, Yann Kolbeinsson, Raphäel Demers, Olivier Mathieu, and François Shaffer. We thank Jacques Leclerc for statistical advice, Michel Melançon and Jean-François Rail for producing Figure 1, and Boisaco Inc. for logistic support. We thank J. T. Ratti, M. C. Zicus, and an anonymous reviewer for helpful suggestions.

LITERATURE CITED

Agresti, A. 2002. Categorical data analysis. John Wiley and Sons, New York, USA.

Andersson, M. and M. O. G. Eriksson. 1982. Nest parasitism in goldeneyes (*Bucephala clangula*): some evolutionary aspects. American Naturalist 120:1–16.

Battin, J. 2004. When good animals love bad habitats: ecological traps and the conservation of animal populations. Conservation Biology 18:1482–1491.

COSEWIC. 2006. Canadian species at risk. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario, Canada.

Cramp, S. and K. E. L. Simmons (Editors). 1977. The birds of the western Palearctic. Volume 1. Ostrich to ducks. Oxford University Press, Oxford, United Kingdom.

Dennis, R. H. and H. Dow. 1984. The establishment of a population of goldeneyes (*Bucephala clangula*) breeding in Scotland. Bird Study 3:217–222.

Doty, H. A. and A. D. Kruse. 1972. Techniques for establishing local breeding populations of Wood Ducks. Journal of Wildlife Management 36:428–435.

Dow, H. and S. Fredga. 1983. Breeding and natal dispersal of the goldeneye. Journal of Animal Ecology 52:681–695.

EADIE, J. M. AND J. FRYXELL. 1992. Density-dependence, frequency-dependence, and alternative nesting behaviours in goldeneyes. American Naturalist 140:621–641.

EADIE, J. M., M. L. MALLORY, AND H. G. LUMSDEN. 1995. Common Goldeneye (*Bucephala clangula*). The birds of North America. Number 170.

EADIE, J. M., J.-P. L. SAVARD, AND M. MALORY. 2000. Barrow's Goldeneye (*Bucephala islandica*). The birds of North America. Number 548.

ERIKSSON, M. O. G. 1982. Differences between old and newly established goldeneye (*Bucephala clangula*) populations. Ornis Fennica 59:13–19.

ERIKSSON, M. O. G. AND M. ANDERSON. 1982. Nest parasitism and hatching success in a population of goldeneyes *Bucephala clangula*. Bird Study 29: 49–54.

ERSKINE, A. J. 1960. Further notes on interspecific competition among hole-nesting ducks. Canadian Field-Naturalist 74:161–162.

ERSKINE, A. J. 1990. Joint laying in *Bucephala* ducks—"parasitism" or nest-site competition? Ornis Scandinavica 21:52–56.

EVANS, M. R., D. B. LANK, W. S. BOYD, AND F. COOKE. 2002. A comparison of the characteristics and fate of Barrow's Goldeneye and Bufflehead nests in nest boxes and natural cavities. Condor 104:610–619.

GRENQUIST, P. 1963. Hatching losses of the Common Goldeneye in the Finnish Archipellago. International Congress of Ornithology 2:685–689.

HEPP, G. R. AND F. C. BELLROSE. 1995. Wood Duck (*Aix Sponsa*). The birds of North America. Number 169.

JOHNSON, L. L. 1967. The Common Goldeneye duck and the role of nesting boxes in its management in north-central Minnesota. Journal of the Minnesota Academy of Sciences 34:110–113.

LUMSDEN, H. G. AND R. WENTING. 1976. Common Goldeneyes hatching from cracked eggs. Auk 93: 833–835.

MARTIN, P. R. AND B. M. DI LABIO. 1994. Natural hybrids between the Common Goldeneye, *Bucephala clangula*, and Barrow's Goldeneye, *B. islandica*. Canadian Field-Naturalist 108:195–198.

MCLAUGHLIN, C. L. AND D. GRICE. 1952. The effectiveness of large scale erection of Wood Duck boxes as a management procedure. Transactions of the North American Wildlife Conference 17: 242–259.

NICHOLS, J. D. AND F. A. JOHNSON. 1990. Wood Duck population dynamics: a review. Pages 83–105 *in* Proceedings of the 1988 North American Wood Duck Symposium (L. H. Fredrickson, G. V. Burger, S. P. Havera, R. E. Kirby, and T. S. Taylor, Editors). St. Louis, Missouri, USA.

PÖYSÄ, H., AND S. PÖYSÄ. 2002. Nest-site limitation and density dependence of reproductive input in the Common Goldeneye *Bucephala clangula*: implications for the management of cavity-nesting birds. Journal of Applied Ecology 39:502–510.

PÖYSÄ, H., M. MILONOFF, AND J. VIRTANEN. 1997. Nest predation in hole-nesting birds in relation to habitat edge: an experiment. Ecography 20:329–335.

PÖYSÄ, H., M. MILONOFF, V. RUUSILA, AND J. VIRTANEN. 1999. Nest-site selection in relation to habitat edge: experiments in the Common Goldeneye. Journal of Avian Biology 30:79–84.

RAJALA, P. AND T. ORMIO. 1970. On the nesting of the goldeneye, *Bucephala clangula* (L.) in the Meltaus game research area in northern Finland, 1959–1966. Finnish Game Research 31:3–9.

ROBERT, M., B. DROLET, AND J.-P. L. SAVARD. 2006. Effects of backpack radio-transmitters on female Barrow's Goldeneyes. Waterbirds 29:115–120.

ROBERT, M., J.-P. L. SAVARD, AND R. BENOIT. 2000a. Status report on the eastern population of the Barrow's Goldeneye (*Bucephala islandica*) in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario, Canada.

ROBERT, M., D. BORDAGE, J.-P. L. SAVARD, G. FITZGERALD, AND F. MORNEAU. 2000b. The breeding range of the Barrow's Goldeneye in eastern North America. Wilson Bulletin 112:1–7.

ROBITAILLE, A. AND J.-P. SAUCIER. 1998. Paysages régionaux du Québec méridional. Les Publications du Québec, Sainte-Foy, Québec, Canada.

ROHRBAUGH, JR., R. W. AND R. H. YAHNER. 1997. Effects of macrohabitat and microhabitat on nest-box use and nesting success of American Kestrels. Wilson Bulletin 109:410–423.

SAVARD, J.-P. L. 1982. Intra- and interspecific competition between Barrow's Goldeneye (*Bucephala islandica*) and Bufflehead (*Bucephala albeola*). Canadian Journal of Zoology 12:3439–3446.

SAVARD, J.-P. L. 1984. Territorial behaviour of Common Goldeneye, Barrow's Goldeneye and Bufflehead in areas of sympatry. Ornis Scandinavica 15: 211–216.

SAVARD, J.-P. L. 1985. Conservation of Barrow's Goldeneye (*Bucephala islandica*): use of nest boxes. Pages 45–51 *in* Proceedings of the 8th Annual North American Bluebird Society Conference (B. Shanty and M. Shanty, Editors). North American Bluebird Society, Red Deer, Alberta, Canada.

SAVARD, J.-P. L. 1988. Use of nest boxes by Barrow's Goldeneyes: nesting success and effect on the breeding population. Wildlife Society Bulletin 16: 125–132.

SAVARD, J.-P. L. AND J. M. EADIE. 1989. Breeding philopatry in Barrow's and Common goldeneyes. Condor 91:198–203.

TOBISH, T. 1986. Separation of Barrow's and Common goldeneyes in all plumages. Birding 18:17–27.

ZICUS, M. C. 1990. Nesting biology of Hooded Mergansers using nest boxes. Journal of Wildlife Management 54:637–643.